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PATENT

REMARKS

For the foregoing reasons, applicant respectfully submits revisions to the specification. A replacement specification is attached herewith.

Should it facilitate allowance of the application, the Examiner is invited to telephone the undersigned attorney. The Commissioner is hereby authorized to charge any additional payment that may be due or credit any overpayment to Novakov Davis Deposit Account No. 50-0208.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Page 2, line 17 through Page 3, line 7:

FIGURE 2 illustrates conventional radio frequency (RF) mixing stage 225 containing down-conversion mixer 250 according to an exemplary embodiment of the prior art. Down-conversion mixer 250 receives an input RF signal, cos(RF), from the receiver front-end amplifiers and a local oscillator reference signal, cos(LO), from a local oscillator and outputs a baseband signal to DC cancellation block 255. Down-conversion mixer ~~255~~ 250, due to mismatches in its internal signal paths, develops a DC-offset at its output. DC-offset cancellation block 255 is required to remove the offset before connecting the mixer output to the baseband filters and automatic gain control (AGC) amplifier block 230. The baseband filters comprise cascading lowpass filters which provide a channel selectivity function. The AGC amplifiers provide programmable gain stages to condition the demodulated signal level.--

Page 5, lines 18-22:

According to a further embodiment of the present invention, the chopping switch is synchronized to the frequency divider such that the ~~switching~~ chopping switch switches its internal connections at the LO/N frequency of the frequency divider and in tandem with the frequency divider.

Page 9, line 17 through Page 10, line 13:

The RF receive path through RF receiver 100 comprises band pass filter (BPF) 105, which receives an incoming RF signal from antenna 106. The RF receive path further comprises low-noise amplifier (LNA) 110, band pass filter (BPF) 115, RF amplifier 120, RF mixing stage 125, and ~~baseband circuitry~~ filters and AGC amplifiers block 130. BPF 105 isolates the frequencies of interest in the incoming RF signal from antenna 106 and filters out unwanted frequency bands. LNA 110 amplifies the filtered output of BPF 105 to an intermediate level. BPF 115 further filters the amplified output of LNA 110 to remove noise outside of the desired receiver frequency range that were amplified by, or introduced by, LNA 110. RF amplifier 120 further amplifies the output of BPF 115 by a variable amount of gain determined by the gain control signal AGC1. RF mixing stage 125 down-converts the output of RF amplifier 120 by mixing it with a local oscillator reference signal. RF mixing stage 125 effectively shifts the information signal centered around the receiver RF operating frequency down to a baseband signal. ~~Baseband circuitry~~ Filters and AGC amplifiers block 130 comprises additional filtering circuitry and automatic gain control circuitry that further improve the quality of the baseband signal from RF mixing stage 125.

Page 12, lines 8-18:

Since output chopping switch 320 switches in tandem with input chopping switch 310, output chopping switch 320 undoes the polarity reversing performed by input chopping switch 310. Thus, the output of output chopping switch 320 is simply an amplified version of the input signal generated by low frequency signal source 305. However, ~~input~~ chopping ~~switch~~ switches 310 and 320 ~~switches~~ switch at a much higher rate than low frequency signal source 305. Because of the continual switching of the input signal, any DC-offset that might normally develop in amplifier 315 is negated, ~~os~~ so that there is zero DC-offset at the output of amplifier 315.

Page 14, line 2 through Page 16, line 8:

FIGURE 4 illustrates selected portions of RF mixing stage 125 in which a down/up-conversion mixer according to the principles of the present invention is implemented. RF mixing stage 125 comprises frequency divider 410, exclusive-OR (X-OR) gate (or analog multiplier) 420, RF mixer 430, filters and AGC amplifiers block 130, and output chopping switch 440. Frequency divider 410 and X-OR gate 420 are inserted into the cos(LO) path of a conventional mixer circuit. This additional circuitry continually reverses the signal polarity of cos(LO) before driving the input of RF mixer 430. The reversing rate of cos(CHOP) is determined by a divisor (N) of frequency divider 410 and is several times lower than the

frequency of cos(LO). However, the reversing rate of cos(CHOP) is still much higher than the frequency of the demodulated baseband signal, cos(RF-LO).

In effect, the modulated cos(LO) down-converts as well as up-converts cos(RF) to a double-sideband suppressed carrier signal at the mixer outputs. This signal type matches the input requirement of the downstream chopper filter/amplifier block. Conventional output chopping switch 440 may be utilized after filters and AGC amplifiers block 130 to recover the transmitted baseband signal ~~after the filter and amplifier block~~. The filters are DSB-IF filters.

Mathematically, the output of the down-conversion mixer is given by the equation:

cos(RF)*cos(LO)*cos(Chop)

= 0.25[cos(ChopB(RF-LO)) + cos(ChopB(RF+LO)

+ cos(Chop+(RF-LO)) + cos(Chop+(RF+LO)]

where cos(RF) is the signal received from the transmitter through the antenna, cos(LO) is the clock from a local oscillator, with LO=RF when there is no modulation, and cos(Chop) is the chopping frequency.

Multiplying these signals together produces four output signals:

1) cos(Chop-(RF-LO));

2) cos(Chop+(RF-LO));

3) cos(ChopB(RF+LO))~~;~~; and

4) cos(Chop+(RF+LO)).

The cos(Chop-(RF-LO)) and cos(Chop+(RF-LO)0 signals are the lower and upper sidebands of the chopped baseband signal. The cos(ChopB(RF+LO)) and cos(Chop+(RF+LO)) signals are by-product terms not contributing to the chopped baseband signal that should be removed by low-pass filters in the baseband filter block.

FIGURE 5 illustrates simple RF mixer 430, which is <u>one embodiment of</u> ~~suitable for use in~~ a down/up-conversion mixer according to the principles of the present invention. RF mixer 430 comprises NPN bias junction transistors (BJT) Q1, Q2, Q3, and Q4 and resistors R1, R2, R3, and R4. Transistors Q1 and Q2 form a first differential pair that receive the chopped cos(LO) signal from the output of analog multiplier 420. The emitters of transistors Q1 and Q2 are coupled directly to each other and to ground via resistor R3. Transistors Q3 and Q4 form a second differential pair that receive the chopped cos(LO) signal from the output of analog multiplier 420. The bases of transistors Q1 and Q4 are connected to the same differential output of analog multiplier 420. The bases of transistors Q2 and Q3 are connected to the other differential output of analog multiplier 420.